Remarks

Claims 1-35 remain in this case. Pending claims 1-31 and 35 are under non-final rejection, while claims 32-34 are objected to. No new claims have been added. No new matter has been added and no additional fees are due for the claims.

Claims 1-2, 8-14, 19-21, 32, and 34-35 have been amended to more clearly set forth the elements of the present invention and to distinguish the present invention from the prior art. No new matter is introduced by this amendment. Support for the claim revisions is found in the specification, specifically: instrumented anode (page 12, line 20), monitoring device (page 11, lines 15-16 and page, 13, line 24 to page 14, line 6), current required to protect the tank (page 16, lines 18-19 and Figures 7-8), calcareous deposit and anticipated lifetime (page 21, lines 6-8), and trends for determining when maintenance will be required (page 16, lines 22-24 and page 19, lines 8-9). The specification has also been amended to correct minor typographical and grammatical errors. In addition, a description of element 15 in Figure 2, which was not previously described, has been added to the specification.

Informalities

In response to the Examiner's inquiry, all claims are considered to be commonly owned by all the applicants.

Information Disclosure Statement

With respect to the Information Disclosure Statement (IDS), Patent No. 5,446,369, as originally indicated on the IDS, is the correct reference. Applicants inadvertently submitted a copy of another patent. Applicants regret any inconvenience this may have caused. Submitted herewith is a copy of Patent. No. 5,466,369 along with a clean copy of the IDS.

Abstract

With reference to the abstract, an amended copy on a separate sheet, is submitted. This corrected abstract deletes the second period at the end of the sentence on line 9.

Claim Rejections – 35 U.S.C. § 112

The Examiner has rejected claim 13 as being indefinite because it is unclear what "type" is intended to convey. Applicants respectfully traverse this rejection. Zinc sacrificial anodes are described in terms such as "ZHC-24" in industry and military standards (as was noted at page 13, lines14-18 of the specification), with the terms indicating the size and style for mounting and the capacity sizing of the anode. This is often commonly referred to as a "type ZHC-24" anode, with "type" merely being used to

suggest an anode style. Applicants maintain that the use of "type" in conjunction with an anode is not indefinite since it merely relates to a common designation of an anode style. However, since the Examiner was confused by this usage, applicants have deleted "type" from the claim.

Claim Rejections – 35 U.S.C. § 102

The Examiner has rejected claims 1-5, 8, 9, 14, 15, 22-24, 28, 29, and 35 under 35 U.S.C. § 102 as being anticipated by Sabins (U.S. Patent No. 4, 107,017). Applicants respectfully traverse this rejection.

According to the Examiner, Sabins teaches a half-cell (#16) measuring a potential of a tank to indicate an amount of corrosion of the tank and the cathodic protection level of the tank (col. 3, lines 33-34) and an anode (#20) measuring a current demand to indicate the amount of corrosion of the tank and the level of coatings degradation. However, a closer review of Sabins shows that this is not the case.

Sabins teaches a portable, hand-held device for measuring the electrochemical effectiveness of a set of sacrificial anodes (on the hull of a ship) using a voltmeter and a probe (i.e. half-cell). While Sabins teaches measuring a potential, this measurement is used only to determine when the sacrificial anodes should be replaced (col. 1, lines 26-27). There is no teaching or suggestion in Sabins that deals with the amount of degradation or damage to the coatings on a surface, either by using a potential measurement or a current measurement. Instead, when the potential is measured at a pre-determined minimum value, the hull sacrificial anodes are replaced. Further, all measurements in Sabins are of potential and all measurements are in volts (refer to columns 4 and 5). *Sabins does not teach the capability of measuring a current.* Sabins mentions current only with respect to connecting the probe (half-cell) to the voltmeter in such a way that the needle will deflect in the correct direction so that a potential (voltage) can be measured (col. 2, lines 49-54). Sabins provides no teaching, and indicates **no** interest in, directly measuring a current. It is therefore apparent that Sabins does not measure a current and provides no teaching or suggestion that a current measurement either could, or should, be used to extract any kind of information dealing with corrosion or tank surface coatings.

According to Sabins, a voltmeter 10 has a positive terminal 12 (connected to anodes 20 attached to a metal surface) and a negative terminal 14 (connected to a half-cell 16 which acts as a probe and is immersed in the electrolytic medium). Also, the half-cell probe (a magnesium alloy) in Sabins is chosen to have an electrochemical reaction potential which is more negative than that of the hull such that polarization does not affect the potential being measured and accurate measurements can be made (col. 1,

line 55 to col. 2, line 12; col. 2, lines 64-65; col. 6, lines 19). To this end, Sabins used a magnesium alloy half-cell instead of the silver-silver chloride half-cell that is normally used (and is used in the present invention). This means that, although the voltmeter scale is set up with reference to a silver-silver chloride half-cell, Sabins actually does not use a silver-silver chloride half-cell. Instead, Sabins uses a magnesium alloy half-cell in order to avoid having polarization affect its potential measurement (col. 4, lines 44-48; col. 6, lines 1-19; col. 6, lines 52-55). Thus, Sabins is concerned with polarization only to justify its use of the magnesium alloy half-cell and does not relate polarization directly to corrosion data. Further, Sabins does not teach that readings obtained as the hull is being polarized provide any useful information. According to Sabins, the hull (or "tank") is not measured during polarization. The hull is always in a fully polarized state and is always fully submersed in the electrolye medium. The hull is not measured out of water in a dry dock situation. Thus, Sabins never measures potential as polarization occurs, but only after polarization has occurred and the potential of the hull has reached a stabilized condition.

In contrast, the inventive apparatus uses half-cells (which are constantly connected via a datalogger to the tank) and provide for polarization measurement of the tank during the initial period of filling through a stabilized polarization state to provide a number of potential measurements. The inventive apparatus also uses an anode (which is isolated from the tank) to provide a current measurement. If either the half-cell or the anode is eliminated, the other element will still provide a measurement that can be used to determine when a tank requires maintenance. Taken together, the two measurements provide additional data that can be used to determine more accurately when tank protection has diminished to the point that it requires maintenance. For example, the current measurement from the tank's instrumented sacrificial anode provides for polarization measurement of the tank during the initial period of filling through a stabilized state provides information (beyond what is available from the potential measurement) that can be used to assess the percentage of damage to the tank coating, growth of calcareous deposition on the cathode surfaces, determine the location of damage to the tank, monitor the change in tank condition over time, predict the life of the anode, and calculate the overall life of the tank coatings (page 14, lines 7-9 of the specification). Also, the present invention does measure potential (and current) as polarization occurs and valuable information is obtained from these measurements and is used to gauge the effectiveness of the hull sacrificial anodes to polarize the structure.

It is therefore apparent that Sabins does not anticipate the base claims (2, 14, 28, 29, and 35) of the present application since it teaches only taking potential measurements. Sabins does not disclose, teach, or suggest taking current measurements to obtain corrosion level information or for any other purpose. These base claims recite new subject matter not disclosed in the prior art and are therefore allowable. Dependent claims 1, 3-13, 15-27, and 30-34 recite additional limitations to base claims that are allowable for the reasons set forth above and are therefore also allowable.

Claim Rejections – 35 U.S.C. § 103

The Examiner has rejected claims 1, 2, 8, 14, 28, 29, and 35 under 35 U.S.C. § 103(a) as being unpatentable over Rizzo (U.S. Patent No. 4,228,399). Applicants respectfully traverse this rejection.

According to the Examiner, Rizzo teaches a half-cell (#16) measuring a potential (col. 1, lines 44-48) of a pipeline to indicate an amount of corrosion of the pipeline and the cathodic protection level of the pipeline (col. 1, lines 44-48) and an anode (#20) measuring a current demand to indicate the amount of corrosion of the tank and the level of coatings degradation (col. 5, lines 36-37). However, a closer review of Rizzo shows that this is not the case.

While Rizzo teaches an apparatus for measuring a potential between a reference electrode (a half-cell trailed in the water proximate to the pipeline) and a pipeline, this measured potential is not the true potential of the pipeline. In order to correct for wire and pipeline resistance errors in this potential measurement, Rizzo must pulse a current along the pipeline while recording/measuring depolarization times (col. 2, lines 43-46). The polarization time data is then used with the measured potential to determine a potential (col. 4, lines 58-66) which then provides corrosion information (col. 2, lines 17-20). Thus, Rizzo does not teach measuring a potential that can provide corrosion information. Instead it uses two sets of measured data (one of which is a potential), to determine the desired potential (col. 6, lines 45-49 and 65-68). Further, Rizzo does not measure any current -- either the current generated in connection with the anode or the additional pulsed test current. Instead, Rizzo applies a test current to a pipeline (col. 2, lines 10-11 and 39-42; col. 5, lines 33-36) and uses the obtained data (which consists only of potential and polarization times) to identify any unusual current requirement (col. 6, lines 64-68). Thus, these unusual current requirements and coatings damage are identified by measuring the rate of recovery (depolarization) of the cathodic protection system when it is perturbed by artificially pulsing a polarizing current onto the already protected structure beyond the existing system capability and not by direct measurement.

In contrast, the inventive apparatus measures both a potential and a current (with the current being related to the cathodic sacrificial/protection anodes) and both provide information about tank corrosion and surface coatings deterioration. Further, the present invention directly measures the current generated in connection with an anode, while Rizzo looks at an additional current, not the anode current, which is used to pulse the system and provide a correction factor to determine an actual potential from the measured potential. In addition, the apparatus taught by Rizzo provides (after the measured data is evaluated) an indication of corrosion on the exterior surface of a pipeline. This apparatus would not function to provide corrosion data for the interior of a tank, which has a more complex structure including structural beams, stiffeners, and void areas wherein the measuring apparatus of Rizzo would not function.

It is therefore apparent that Rizzo does not render obvious base claims 2, 8, 14, 28, 29, and 35 of the present application since it teaches determining – not directly measuring -- potential measurements. Rizzo also does not disclose, teach, or suggest taking current measurements to obtain corrosion level information or for any other purpose. These claims recite new subject matter not disclosed in the prior art and are therefore allowable. Dependent claims 1, 3-7, 9-13, 15-27, and 30-34 recite additional limitations to base claims that are allowable for the reasons set forth above and are therefore also allowable.

In view of this amendment and remarks, applicants respectfully request reconsideration and allowance of the claims of this application. The Examiner is invited to contact applicants' attorney at the number indicated below should further discussion help advance the case.

Please charge any additional fee, or credit any over-payment, to Deposit Account No.50-0281.

Respectfully submitted,

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Response Due (with 2 month
Extension of time): November 13, 2002
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VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

In the paragraph beginning at page 1, line 1:

The present invention relates to ~~an~~ corrosion monitoring system, which is used to provide an overall assessment of the materials degradation and the condition of protective coatings in a tank structure in which the metal is subject to corrosion, and particularly relating to a corrosion sensor for use in tanks which contain or intermittently contain conductive electrolyte.

In the paragraph beginning at page 7, line 12:

A tank corrosion monitoring system that accurately monitor~~eds~~ the coatings degradation and corrosion level, and which measures the current output from an instrumented sacrificial anode and measures the potential from at least one reference half cell is disclosed herein.

In the paragraph beginning at page 8, line 10:

Objects of the present invention are achieved by providing an apparatus which includes first a means for measuring a potential which corresponds to a polarization of a tank. The apparatus also includes a second means for measuring a current output of the tank. The polarization and the measured current output together indicate~~s~~ an amount of corrosion ~~to~~ of the tank and the amount of tank coatings loss.

In the paragraph beginning at page 10, line 7:

Fig. 10 is a graph of tank polarization test results for tank filling episode in a tank with 1 to ~~2year~~ 2 year old tank protective coating.

In the paragraph beginning at page 13, line 1:

In order to provide a low resistance ground connection, the anode wire 34 is attached to the sacrificial anode 3 at electrical connection 19. The anode wire 34 is of sufficient gauge to carry the magnitude of current without a voltage drop, typically equivalent to that normally provided by the anode at a direct ground metallic connection. The sacrificial anode wire 34, here contained within cable 4

(shown in Fig 1), connects through the reference half-cell and connects directly to a shunt resistor 9. The shunt resistor of this embodiment is a low wattage (1-3 Watts), very low resistance (0.1 ohm) resistor and does very little to impede the flow and magnitude of current to ground. Because the shunt resistance is low, the slight voltage drop read across the shunt resistor 9 can be equated directly to the instrumented sacrificial anode current. Electrical leads 33 attached to the ends of the shunt resistor feed into the datalogger 6 and provide both a hull ground reference point and anode current output data, which are stored by the datalogger. Tank ground 15 connects to tank hatch 7, grounding the system.

IN THE CLAIMS:

1. An apparatus according to claim 2, said apparatus further comprising:

a half cell measuring a potential of a tank, the measured potential indicating an amount of corrosion of the tank and ~~the~~ a cathodic protection level of the tank.

2. An apparatus ~~according to claim 1, said apparatus further~~ comprising:

an instrumented anode for directly measuring a current demand of cathodic areas of a tank, said instrumented anode positioned separate from and electrically isolated from the tank, with the current demand indicating ~~the~~ an amount of corrosion of the tank and ~~the~~ a level of coatings degradation.

8. An apparatus comprising:

an instrumented anode measuring a current demand of cathodic areas of a tank, the current demand indicating an amount of ~~corrosion of~~ current required to protect the tank.

9. An apparatus according to claim 8, wherein the indicated amount of ~~corrosion~~ required current is in one of at least two different ranges.

10. An apparatus according to claim 9, wherein the measured current output is below a specific level indicating that the amount of ~~corrosion~~ required current is in a first range of said one of at least two different ranges.

11. An apparatus according to claim 9, wherein the measured current output is within a specific level indicating that the amount of ~~corrosion~~ required current of the tank is between a first and second range of said one of at least two different ranges.

12. An apparatus according to claim 9, wherein the measured current output is above a specific level indicating that the amount of ~~corrosion~~ required current of the tank is in a second range of said one of at least two different ranges.

13. An apparatus according to claim 8, wherein the anode is an instrumented sacrificial anode which uses ~~a type~~ ZHC-24 zinc.

14. An apparatus comprising:

half cells measuring a potential which corresponds to a polarization of a tank; and

an anode measuring a current demand of cathodic areas of a tank, said current demand indicating an amount of calcareous deposit on surfaces of the tank, and the polarization and the measured current demand together indicating an amount of corrosion of the tank and ~~the~~ a level of coatings degradation, said polarization and current demand further providing an anticipated lifetime before exhaustion of sacrificial anodes in the tank.

19. An apparatus according to claim 15, wherein the measured current demand is below a specific level indicating that the amount of ~~corrosion~~ coatings degradation is in a first range of said one of at least two different ranges.

20. An apparatus according to claim 15, wherein the measured current demand is within a specific level indicating that the amount of ~~corrosion~~ coatings degradation is between a first and second range of said one of at least two different ranges.

21. An apparatus according to claim 15, wherein the measured current output is above a specific level indicating a condition in which an amount of ~~corrosion~~ coatings degradation is in a second range of said one of at least two different ranges.

32. An apparatus as in claim 1, further comprising:

a second half cell for measuring a potential of said tank,

wherein said half cell and said second half cell measure potential at different levels of a tank, said measured potential indicating a level of fluid in the tank.

34. An apparatus as in claim 33, further comprising a ~~tank level indicator~~ monitoring device for continuously tracking trends in said potential and said current output measurements as they change over time.

35. A method for determining whether a tank requires maintenance comprising:

measuring a potential which corresponds to a polarization of a tank during ~~the~~ a filling episode of ~~a~~ the tank,

measuring a current output of an instrumented sacrificial anode during the filling episode of ~~a~~ the tank,

comparing said potential and said current output with preset levels to determine whether a tank requires maintenance, and

if not maintenance is currently required, determining a time when maintenance will be required .